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Native iron in the sediments of Lake Baikal (*borehole BDP-98*): results of thermomagnetic analysis

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Abstract

We performed a thermomagnetic analysis of 91 samples and a probe microanalysis of five samples of sedimentary rocks from the lower zone of the borehole BDP-98 drilled at the bottom of Lake Baikal. The results show the scarcity of native iron: It was found only in five samples. Its concentration varies from ~10^{-5} to 7×10^{-4}%. The distribution of native iron by content is bimodal, with a distinct "zero" mode. This scarcity of native iron in the Baikal sediments distinguishes them from continental (Eurasia) and oceanic (Atlantic) sediments of different ages. It is due to the high rate of sedimentation in the studied interval of BDP-98.

Keywords: thermomagnetic analysis; probe microanalysis; sediments; native iron

Introduction

In recent years, we have accumulated voluminous data on native iron particles in epicontinental sediments in different regions of Eurasia and in the Atlantic sediments (cores from the boreholes DSDP 386, DSDP 387, 391A, and 391C). The examined sediments are of different ages (Miocene, Oligocene, Eocene, Cretaceous, Late Jurassic, and Early Cambrian). The content and composition of iron particles in the sediments were studied by thermomagnetic analysis (TMA) with heating to 800 ºC and probe microanalysis (PMA) (Grachev et al., 2009; Pechersky and Sharonova, 2012; Pechersky et al., 2008, 2011, 2013). The main results of these studies are as follows. Epicontinental and oceanic sediments often contain traces of native iron microparticles (usually ≤0.001%). There is no correlation between their contents and the sediment lithology as well as the content of terrestrial Fe-containing minerals (magnetite, iron hydroxides, etc.). This argues for the predominantly cosmic origin of the particles, and their ubiquitous occurrence indicates their relation with cosmic dust. Three groups of metallic iron particles are recognized: (1) pure iron; (2) Ni-containing iron, with Ni = 5–6% (kamacite); and (3) Fe–Ni alloy, with >20% Ni, up to pure Ni. Most of particles belong to groups 1 and 2. They are ubiquitous, thus reflecting the regular presence in cosmic dust. Particles of group 3 are of local occurrence and are, most likely, the product of meteorite fragmentation.

Native iron particles were earlier discovered in deep-water oceanic sediments and manganese concretions (Brownlee, 1985; Fredriksson and Martin, 1963; Grachev et al., 2008; Murray and Renard, 1891; Parkin et al., 1980). Along with iron of cosmic origin, the sediments abound in iron particles related to volcanic activity, bacterial activity, and metamorphism (Frost, 1985; Lukin, 2006; Novgorodova, 1994; Shterenberg and Vasil'eva, 1979). Therefore, it is important to find signs of difference between native iron of cosmic and terrestrial origin.

Native iron particles in lacustrine sediments have not been studied by thermomagnetic analysis yet. The goal of this work was to investigate such particles in the Baikal sediments and determine their abundance and composition by TMA and PMA.

For study, we sampled sediments from the lower section of the borehole BDP-98. They formed in the paleodelta of the Barguzin River and were characterized by a high rate of accumulation in contrast to the sediments in the upper section of the borehole, which deposited under deep-water basin

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